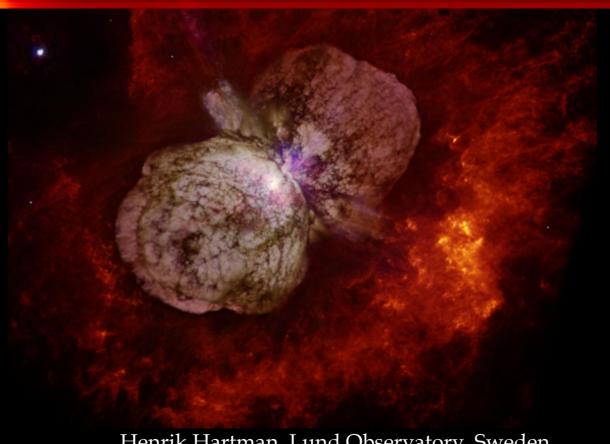
Eta Carinae in the context of the most massive stars: a dedication to Sveneric Johansson (1942-2008)



Henrik Hartman, Lund Observatory, Sweden IAU GA XXVII, Joint Discussion 13, Aug 3-14, 2009

Sveneric Johansson (1942-2008)





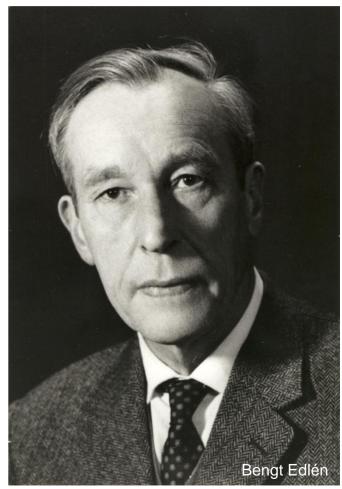
- PhD at Lund University (1978), Sweden, with Prof. Bengt Edlén, Spektroskopiska undersökningar av Fe II'.
- Sabbatical at Goddard Space Flight Center (MD/USA) during 1987-88.
- Professor 1999 and founder of the Atomic Astrophysics group 2001 and the Edlén Laboratory at Lund Observatory.
- Classical atomic spectroscopist with an unusual feeling for atomic spectra and atomic structure, especially the iron group elements.





Several major astronomical discoveries originate in laboratory investigations, performed for their intrinsic interest and not primarily aiming for a specific astrophysical problem.

- **Ira Bowen**, suggesting fluorescence (Bowen mechanism) in 1924 and identification of the first forbidden lines, [O III] in 1928.
- Bengt Edlén, Identification of highly ionized carbon, nitrogen and oxygen (e.g. C III, C IV, N IV, N V and O IV) in Wolf-Rayet stars.
 - He also identified the coronal lines with fine structure transitions in highly ionized iron group elements, e.g. FeX and Fe XI.





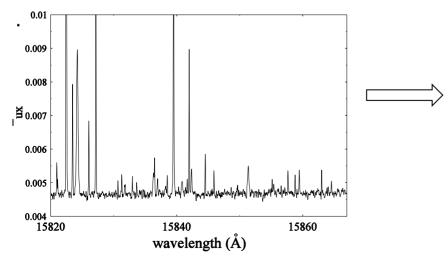
Scientific achivements – term analysis

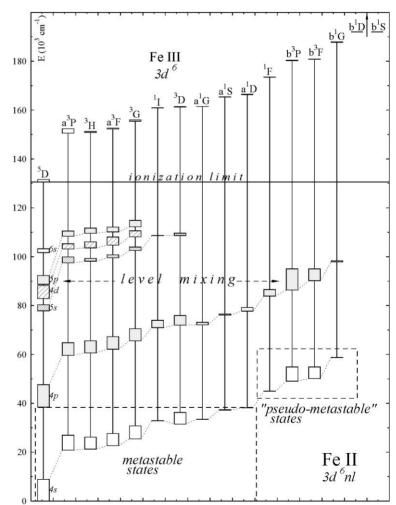
Skilful atomic spectroscopist with a feeling for term analysis.

Analyses on important iron group elements, primarily Fe II, but also, Sc II, Ti II, Cr II

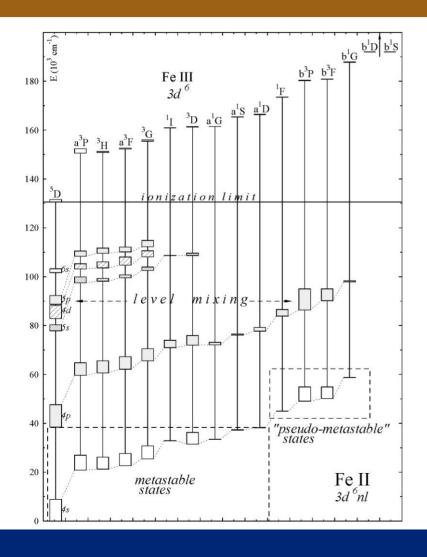
Early investigations in the near infrared wavelength range, in the 1970's

Later FTS measurements in UV-opt.





Scientific achivements – term analysis of Fell



1972 given FeII as PhD project, but only investigations to 1 μm, since longer wavelengths 'will never be observed by astronomers' (Edlén, 70's). 300 levels known by then.

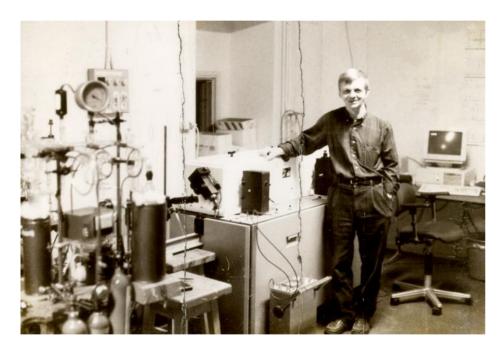
Over 1000 energy levels known (2009).

The last of these, 3d⁵(⁵S)4s4f, were identified in the spectrum of HR6000, the first identified from a stellar spectrum.

Absorption requires population in the lower level, whereas emission needs population in the upper level. What is the result on the analysis?

Are not 300 levels sufficient?

Scientific achivements – HST lab spectroscopy



Sveneric Johansson foresaw the need of high-resolution, high-accuracy atomic data in the UV with the upcoming HST.

Together with Dave Leckrone on the pathfinder project on χ Lupi:

Wavelengths, line profiles (isotopes) and line stengths.

Here seen with the Lund UV-FTS.

Main scientific achivements

- Early HST spectroscopy and dedicated laboratory analyses for this.
- χ Lupi, one of the first targets for HST/Goddard High Resolution Spectrograph, where many elements were observed for the first time except for the sun.
- Spectroscopic investigations of iron, yttrium, mercury, boron, gold, rythenium, nickel, thallium, platinum, zirconium
- Wavelengths, isotopic structure, and oscillator strengths.
- The FERRUM project evaluated oscillator strengths
- Analysis of HST spectra (Davidson and Gull), and later photoprocesses with V. Letokhov.

formation of planets in this and perhaps

Bruhweiler et al., in observations of ionized iron (FE II) near a wavelength of 260 nm, made with the International Ultraviolet Explorer (IUE) satellite, reaches a maximum velocity of only 60 km s⁻¹, whereas the photospheric escape velocity for β Pic is close to 700 km s-1. This gravitationally and become infalling gas. A gas componen infall is probably of stellar, rather than cometary origin. This is the first demonstrainfall is probably of stellar, rather than HUBBLE SPACE TELESCOPE

wards at B Pic. Although both the rates of mass infall and outflow are variable, the largest measured infall event is 50 times more massive than the largest of the two observed outflow events. Although these observations demonstrate that some of the circumstellar show that stellar pulsations cannot account for all of the gas. Star-grazing comets are still the only viable explanation for producing much of the infalling gas.

David A. Weintraub is in the Department



NEWS AND VIEWS

Real science at last

ASTRONOMERS working with the Hubble Space Telescope (HST) are no longer preoccupied with proving to the public that the flaws in the satellite's optics were not fatal. After six months of spectacular images derived from the telescope's testing runs, the first new scientific data are being gathered, and several unexpected observations were

Much of the interest is in data obtained Wavelength (Å)

FIG 1. New (bottom) and old (top) spectra of y Lup by the HST's two spectrometers, the highesolution and faint-objects spectrographs (HRS and FOS), both designed to operate primarily at ultraviolet wavelengths to which the Earth's atmosphere is opaque. The spectrum shown above (Fig. 1; D. Leckrone et al. Goddard Space Flight Center), a 2-ångstrom-wavelength interval of measurem of the hot, chemically peculiar star χ Lupi shows what the HRS can achieve in compar son the best that had previously been obtained by the long-serving International Ultraviolet Explorer (IUE). The greatly magnified spectral resolution turns a wiggly ine into a forest of atomic identifications. The advantage of ultraviolet stellar spectroscopy is that it includes low ionization lines of ost all the elements, and when the elements in question are of relatively low abun-

NATURE · VOL 351 · 6 JUNE 1991

Further spectra of χ Lupi turned up some novelties, and deepened some previous mys-teries. Traces of ruthenium and arsenic were found, the first discovery of these elements in a non-solar astronomical spectrum. And the abundances of mercury and platinum, already known to be anomalously large, were estimated at 105 and 104 times solar abundance, respectively. The puzzle is that y

Lupi has the brightness and colour of a relatively young, hot massive star, but has the heavy-element abundances that would be expected of a cool. highly evolved star after a lifetime of nucleosynthesis. Spectroscopy also produced

results of important but uncertain cosmological significance For some years, observations dense patterns of absorption lines in the spectra of quasars, the most distant of astronomical objects; the lines have been

attributed to the presence of hydrogen clouds at intermediate distances. The further away the clouds are, the more their Lyman-o absorption line is redshifted from the ultraviolet towards longer wavelengths in the optical waveband, by cosmological expansion. Optical observations have sugge that the density of Lyman-rt clouds decreases to shorter wavelengths, meaning that closer and therefore older clouds are less vounger ones. This hinted that the clouds were some sort of leftover from galaxy formation

FOS found over a dozen Lyman-α clouds in the interpretation now is that the a section of the ultraviolet spectrum of the bright quasar 3C273 in which only one would have been predicted by extrapolation from previous results (Ray Weymann, Mount Wilson and Las Campanas Observa-

tories). Before HST, no instrument had had both the sensitivity and spectral resolution to search for Lyman-α clouds in the ultraviolet; line by IUE turned into several lines in the The quantity of hydrogen implicated in a

typical Lyman-α cloud is a column density of about 1014 atoms per cm2 - a nanogram spread out over an unknown but presumably large diameter. Even clouds close by, identi-fied by HST spectroscopy, will be impossible to detect in any other way, so that their comological origin and significance must be

These spectroscopic results contained would be complete without images. The oright star η Carinae provides a most striking before and after' comparison. The star is of sistorical note: it flared from a nondescript 6th magnitude to a remarkable -1, only jus less bright than Sirius, in the middle of the last century, then faded over the next decades back to 6. The best guess at the structure, building on what was previously known of its history and on barely resolved that the star shed a lot of mass violently, creaalong what was presumably the polar axis,

The new HST observations (Fig. 2), how ever, turn this picture not upside down, but Field/Planetary Camera) image shows the lobes but reveals seeming jet-like structure at right angles to them (J. Hester, California seems to run into a shock, presumably when behind it is a curious ladder of bright lines other side, the jet seems to have encountered a higher density of material, and pushes out a sort of 'mushroom cap' of expanding material. Regardless of all these details signify the polar axis, and that the bright cross-section.

RVMQLE RV

Conference organiser

- Initiated the international triannual conference series:
 Atomic Spectroscopy and Oscillator Strengths (ASOS), first held in Lund 1983 and most recently in 2007 was held in memory to Svenerics retirement.
- Hosted the 'Eta Carinae and other mysterious stars' conference on Hven in 2000.

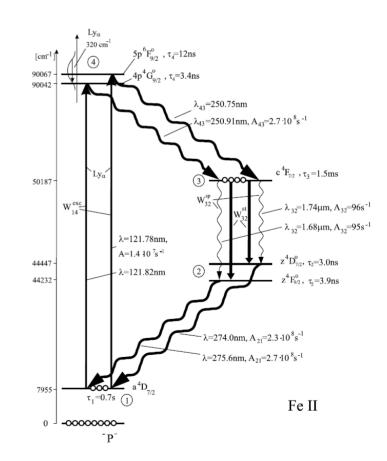


Photoprocesses in astrophysical plasmas applications to Eta Carinaes ejecta

- Identification of fluorescence mechanism in symbiotic stars and stellar winds.
- Suggested stimulated emission in Fe II lines observed in Eta Carinaes ejecta, based on line rations in FeII UV lines at 2506/8 Å.

Johansson and Letokhov:

- Concept of Resonance Enhanced Two-Photon Ionization (RETPI) to explain the strengths and anomalous behaviour of spectral lines in the spectrum of Eta Carinae.
- LASER routes in Fell and other ions.



Vladilen Letokhov (1939-2009)



- Specialized in the field of atomic physics and laser theory. Early work of laser cooling and Bose-Einstein condensates.
- Head of Laser Spectroscopy Department, Troitsk, Moscow. Guest professor at several institutes.
- Almost 900 published papers, and 15 monographs.
- Most frequently cited Russian scientist in all fields 1973-1988. (ISI, 1990)



RVMQLE RV

In memorian



Sveneric Johansson and Vladilen Letokhov sadely passed on during the last year. Their final publication 'Astrophysical Lasers' was published earlier this year.

